PB-215 360

REPORT ON OIL SPILLS AFFECTING THE MINNESOTA AND MISSISSIPPI RIVERS, WINTER OF 1962-63

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1963

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

HE 20.2: .2: 015
015

PB 215 360

Report on

Oil Spills Affecting the Minnesota and Mississippi Rivers

Winter of 1962-63

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service

HE 20.2: U.S. Health, Education & Welfare
Public Health Service
General publications

Oi5 Report on oil spills affecting Minnesota and Mississippi Rivers, winter of 1962-63 [with list of references]. 1963. (Division of Water Supply and Pollution Control, Technical Services Branch, Technical Advisory and Investigations Section, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio) (LC 79-613588) 8/11/72

Copy to NTIS 8/72

Report on

Oil Spills Affecting the Minnesota and Mississippi Rivers

Winter of 1962-1963

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
Technical Services Branch
Technical Advisory and Investigations Section

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1963

TABLE OF CONTENTS

Preface ii

Acknowledgements. iv

Summary v

Introduction. 1

Data Presentation 2

Richards Oil Company. 2

Honeymead Products Company. 4

Chemistry of Soybean Oil. 6

Public Health Significance. 7

Effects of Oil Pollution. 8

Public Health Service Participation 9

Field Sampling and Laboratory Analyses. 13

Crude Soya Oil Studies. 13

Studies of Mississippi River Water. 15

Bottom Sediment Studies 21

Legal Aspects 23

References. 24

Appendices. 25

A. Soybean Oil Leaching Studies 26

B. Chronology of Events and Activities. 30

C. Persons Contacted or Associated with the Problem. 37

PREFACE

Two separate oil spills occurred on the Minnesota River during the winter of 1962-63. The first spill, of petroleum oil, occurred at Savage, Minnesota in December 1962 and the second, of soybean oil, at Mankato, Minnesota in January 1963. During the spring ice breakup, these oils discharged to the Mississippi River at St. Paul and dispersed into several off-channel lakes between St. Paul, Minnesota, and Alma, Wisconsin, and resulted in the death of several thousand wild ducks.

State concern for the protection of wildlife and the public welfare prompted a declaration of emergency by the Governor of Minnesota on April 3, 1963. The National Guard was called to active duty to cope with the situation. Some of the National Guards proposed remedial activities included removal of oil from the water surface, construction of floating booms to divert oil from off-channel waters, and assistance in rescue of immobilized ducks and other wildlife.

Early in April Governor Rolvaag requested the assistance of the Public Health Service as authorized by Section 4b, P.L. 660. This request initiated action by Public Health Service personnel in Regions V and VI, and the Technical Advisory and Investigations Section (TA&I) of the Technical Services Branch stationed at the Sanitary Engineering Center (SEC). The TA&I Section proceeded with field surveys during April and June.

The object of this report is to present highlights of events and results of activities and studies conducted by the various Federal, State and local agencies during the period December 1962 to June 1963, with particular emphasis on PHS activities, and to record the information for future reference and use in case of similar occurrences elsewhere.

ACKNOWLEDGEMENTS

The Public Health Service wishes to acknowledge the cooperation of State and Federal agencies which provided support and assistance in the activities of Service personnel.

It is impractical here to name the hundreds of private citizens and small groups who contributed to the cleanup and wildlife rescue operations on the Mississippi River, however, the major agencies that contributed personnel and assistance to solve the many technical, logistic, and administrative problems associated with the oil spills are listed here.

State of Minnesota

- Governor's Office
- National Guard
- Health Department
- Water Pollution Control Commission
- Conservation Department
- Game and Fish Division
- Attorney General's Office

State of Wisconsin

- Governor's Office
- Resources Development Division

Corps of Engineers, U. S. Army

U. S. Fish and Wildlife Service

U. S. Coast Guard

SUMMARY

Two separate oil spills on the Minnesota River during the winter of 1962-63 resulted in the pollution of the Minnesota and Mississippi Rivers with approximately 1-million gallons of petroleum cutters oil and 2.5 million gallons of soya oil.

These spilled oils accumulated on and under the river ice. The petroleum cutters oil moved into the Mississippi River first as this spill occurred six weeks before the soya oil spill, entering the Minnesota River at Savage, about 12 miles above its confluence with the Mississippi. Because the petroleum oil was of a light fraction it buoyed to the water surface and tended to move more rapidly downstream than the soya oil. The soya oil entered the Minnesota River at Mankato, approximately 76 miles above the confluence with the Mississippi River. The [illegible] of passage in the Minnesota River from Mankato to Savage plus the six weeks calendar time between oil spills represents a long soya oil-water-air contact time. Because the soya oil oxidized and polymerized when exposed to water and air and mixed with silt and debris its specific gravity was increased, and tended to settle to the bottom in quiescent areas. In the early stages of change, however, the soya oil formed a floating mass with a consistency similar to soft putty and with an adhesive quality. The color varied from brownish or tan to gray with a slight yellow cast. Much of this material floated on the water surface and was blown onto shores by winds.

The largest accumulation of oils on the Mississippi River from St. Paul to Lake Pepin occurred at the time the river ice broke up in late March or early April. This accumulation moved downstream to Lake Pepin where it was temporarily held back by the ice cover on the lake. This forced the oils to spread to the many off-channel lakes and marshes where wildlife abounded. The sticky, oily material adhered to anything it contacted resulting in loss of wildlife. Ducks in particular were susceptible to this pollution, their losses numbered in the thousands.

Soon after the oil spills occurred several agencies worked on this problem to prevent additional oil losses to the streams. The full impact of this problem, however, was not evident until the ice breakup in the spring. The Governor of Minnesota declared an emergency, activated two units of the National Guard, alerted the Health Department and Conservation Department, and received aid from personnel of Corps of Engineers, U. S. Fish and Wildlife, Coast Guard, and the Public Health Service (PHS).

The PHS arranged for collection of a series of Mississippi River water samples, bottom sediment samples, and oil samples from the two plants involved for study and evaluation.

Analytical results indicated the ranges in total ether-extractable oils and the extractions were identified by infrared spectrophotometry as principally of soybean oil.

Oil samples scraped from dead ducks were identified by the State Water Pollution Control laboratory as soybean oil in most cases, with petroleum oil present in a few samples.

PHS studies showed that the ultimate oxygen demand of the original crude soya oil was very high; however, the oily masses floating and bobbing in the river water exerted an oxygen demand at a slow rate which indicated that the materials settling to the bottom could depress the dissolved oxygen in Lake Pepin for a long period of time.

Bottom sediments exhibited a relatively similar oil content at given stations for the two sampling runs in April and June. The biological life in April was considered normal and active whereas in June very little biological activity was evident.

A chlorine concentration of 5.3 milligrams per liter (mg/l) applied to a soya oil concentration of 5 mg/l in distilled water produced odor free water and a combined chlorine residual of 4 mg/l after 2 hours contact time.

Oil extractions from Mississippi River water showed a median concentration of 1.3 and a maximum of 4.0 mg/l indicating no significant problem would be expected at water treatment plants. Increased applications of chlorine and coagulant chemicals may be necessary, however, in some plants receiving water with higher concentrations of soya oil.

Carbon filter studies at three Mississippi River stations of the National Water Quality Network indicated no significant changes in the water's chemical quality during the period of study.

The great loss of wildlife and the stranding of oil on the shores and recreation areas caused many complaints from the public and organized groups.

The Minnesota State Legislature recognized the need to strengthen the Water Pollution Control Law and passed a new law that gives the Water Pollution Control Commission broader powers and responsibilities for the control and prevention of pollution in both surface waters and underground waters.

INTRODUCTION

During the week of April 8, 1963, the Public Health Service made preliminary surveys of the Richards Oil Company Plant, the Honeymead Products Company Plant, the Blue Earth River, the Minnesota River and the Mississippi River.

Stream and bottom samples were collected from April 16 to 22 and again on June 25 and 26 from the Mississippi River and backwaters at several points from St. Paul through Lake Pepin. The river, lake, and backwater sampling was carried out with the assistance of personnel of the State Water Pollution Control Commission.

Arrangements were made with the Corps of Engineers to collect daily water samples from the Mississippi River at Locks and Dams Numbers 2 through 15 for a period of 20 days beginning April 13. River water and bottom samples were examined at the Robert A. Taft Sanitary Engineering Center (SEC) for oil content. Special studies on soya oil included taste and odor, chlorine demand, biochemical oxygen demand (BOD), and leaching characteristics.

The PHS water quality network stations at St. Paul, Dubuque and Burlington furnished background data from samples analyzed before the oil spill incident. Arrangements were made with these stations for continuous carbon-filter sampling of the river water for the period April 21 to May 12, 1963.

The Rock Island Arsenal water treatment plant personnel supplied Mississippi River water samples to the PHS for analysis each week for the period April 26 to June 14. This arrangement was made through the cooperation of the Corps of Engineers and PHS Region V.

DATA PRESENTATION

Information on the oil spills at Savage and Mankato, Minnesota are presented, followed by a discussion of the problems on the Mississippi River below Minneapolis-St. Paul with special emphasis on PHS activities.

Richards Oil Company Terminal, Savage, Minnesota

Richards Oil Company, 201 Fremont Avenue North, Minneapolis, Minnesota, operates an oil barge terminal and oil tank farm located between the south bank of the Minnesota River and Minnesota Highway No. 13, approximately 1 mile northwest of Savage, Minnesota. The company reportedly is owned by Myron Richards and his family. The operation consists essentially of receiving and storage of industrial oils and dispensing them to local industries.

The highway terminal located 0.8 miles south of the barge unloading facility consists of two large oil storage tanks that hold approximately 1 million gallons of oil each and five smaller tanks surrounding the depot.

Pumps to unload the oil tankers are installed in a barge permanently tied up on the bank of the river. These pumps discharge the oil

through a large flexible hose connected to a 10-inch pipe line to the highway terminal, or the oil may be pumped into one of three oil storage tanks installed on the river bank. The 10-inch pipe line manufactured from 3/8 inch thick welded steel, is laid on the surface of the ground for a distance of 0.8 miles. A rectangular steam heating duct is welded to the top of the pipe line. This pipe passes through two dyked lagoons located between the highway terminal and the river. A dirt access road from the highway to the barge unloading site on the river bank serves as the west dyke for the two lagoons.

During the severe winter of 1962, this welded steel pipe line was fractured in three places, one in the south lagoon and two in the north. These fractures occurred on December 8, or 9, and were discovered by plant employees when they returned to work on Monday, December 10. The gate valve at one of the million-gallon tanks was open at the time of the pipe line fracture, and the cutters oil comparable to No. 2 fuel oil and reportedly a mixture of light mineral oil and xylene, drained from this tank through the fractured pipe. Because the culverts beneath the access road had never been closed, the oil drained into the lagoons, flowed through these culverts into the roadside ditch west of the access road, and thence flowed into the Minnesota River.

A steel plate, suspended across the ditch in March 1963, served as a skimmer to hold back the floating oil, which was either skimmed or burned off the water surface. The saturated ground in the lagoons, embankments, and sides of the roadside ditch continued to bleed oil for some time.

The Northern States Power Company in the latter part of December 1962 reported oil in the Minnesota River. This power plant (Black Dog) is located near the Minneapolis-St. Paul Airport at the south edge of Minneapolis, approximately 8 stream miles below the point oil entered the Minnesota River. The power company complained that oil was affecting heat transfer in the turbine condensers. Inasmuch as this pipe line break occurred early in December, it is apparent that oil flowed directly into the river and downstream under the ice.

Honeymead Products Company, Mankato, Minnesota

The Mankato Plant of Honeymead Products Company is located on the east bank of the Blue Earth River, approximately 1/4 mile above its confluence with the Minnesota River. The Company has pioneered in the processing of soybeans and refining soybean products. These products are used for human consumption, livestock feeding, and industrial purposes. The following products are listed in a brochure describing Honeymead Products Company operations at Mankato.

Soybean Oils

Crude
Degummed
Once Refined
Clearsoy - Non-break
Lustersoy - Alkali Refined and Bleached
Savorysoy - Deodorized
Lecithin

Flours and Flakes

Lamisoy - Industrial grade for adhesives
De-fatted Soy Flour
Soybean Brew Flakes-yeast food

Protein Products
Meals and Pellets

44% Soybean Oil Meal
Lecithinated Soybean Oil Meal
Hi-energy Soybean Oil Meal
Soybean Oil Meal Pellets

On January 23, 1963, one of the crude oil storage tanks ruptured and released 2-1/2 million gallons of crude soybean oil to the surrounding area; a large quantity escaped to the Blue Earth River. Five smaller tanks were moved by the explosion and likewise released their contents of salad oil estimated at 1/2 million gallons. Two railroad box cars, partially loaded with 55 gallon drums of lecithin, were overturned; some of the drums burst.

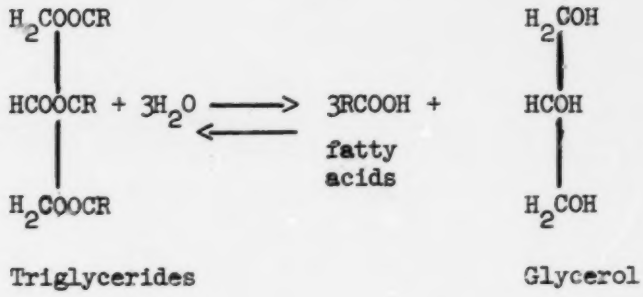
A concerted effort was made by Honeymead Products Company to recover these soybean products. The minus 20°F temperature that caused the oil to solidify facilitated recovery. Pictures taken by Health Department personnel before the cleanup indicated that the soybean oil spread over the ground for significant distances, and a considerable amount flowed to the river and remained on the top of the ice. A bulldozer employed in the oil recovery operation crashed through the river ice. It is estimated that between 700,000 and 800,000 gallons of soybean oil were recovered. The amount of salad oil recovered is not known as it was partially mixed with other oils on the ground. Because of the viscous nature of lecithin, it is doubtful if much of this product entered the Blue Earth River, however, three of the ruptured lecithin drums, partially filled with lecithin, were observed at the water's edge along the south bank of the Blue Earth River on April 12. It is evident that a significant quantity of crude soybean oil and salad oil proceeded down the Blue Earth River and the Minnesota River into the Mississippi during the period when the ice went out (late March and early April).

Crude soybean oil is slightly lighter than water and is worth approximately ten cents a pound. Some of the recovered oil was fed to hogs in the Mankato vicinity. Surface runoff from this feed lot reportedly entered a ravine, which in turn discharged to the Blue Earth River. Oil wastes were also dumped on land 2 miles east of Rapidan. A temperature rise and rainfall runoff caused this material to flow into the Le Sueur River, a tributary to the Blue Earth River. Based on available information, it appears that the combined volume of crude soybean oil and salad oil entering La Sueur River, Blue Earth River, and the Minnesota River was about 2.5 million gallons. This allows 500,000 gallons consumed as hog feed.

Chemistry of Soybean Oil[2]

Soybean oil is composed of the triglycerides of oleic acid 26 per cent, of linoleic acid 49 per cent, of linolenic acid 11 per cent, and of saturated acids 14 per cent. Free fatty acids are usually less than 1 per cent and phospholipids 1.5 to 4 per cent. The color is pale yellow to brownish yellow. The flavor of crude soybean oil has been described as paint-like and grass-like. The flash point is 540°F and ignition temperature is 835°F. The oil solidifies at +3 to +14°F.

The phospholipids (lecithin) in crude soybean oil will precipitate upon the addition of a small amount of water. Triglycerides of vegetable origin, such as soybean oil, also undergo hydrolysis to constituent fatty acids and glycerol. The reaction can be represented thus:



The R groups represent the alkyl portion of the structure. In addition to the hydrolysis of fat, a secondary reaction also occurs, namely oxidation. For this reaction, the unsaturated fatty acid fragments are oxidized at their double bonds with the ultimate production of aldehydes, ketones, and acids with fewer carbon atoms in the molecule. Different unsaturated fats do not oxidize in the same time. However, once oxidation starts, all unsaturated fats absorb large quantities of oxygen with considerable rapidity. This can result in a high chemical oxygen demand.

Public Health Significance

According to information in our files,[3] no undue hazard to public health would be expected to result from the ingestion of water that may contain unprocessed soybean oil. Generally, commercial crude soybean oil is obtained from soybeans by hexane extraction and is then refined by alkali treatment, adsorptive decolorization and deodorization to produce refined oils that are the main ingredients in salad oils, hardened shortenings, and margarine. For many years the crude oil has been directly used as food in the Orient but its flavor (described as paint-like and grass-like) is somewhat distasteful to the palate of occidentals who are more accustomed to the bland-type oils.[4]

The composition of crude and refined oils determined by gas-liquid chromatography has been reported[5] to be:

Non-heated oils	Free fatty acids, %	Fatty acid composition (triglycerides) %				
		Palmitate	Stearate	Oleate	Linoleate	Linolenate
Crude	0.8	11.4	4.3	28.4	49.7	6.2
Refined	0.05	11.9	3.7	27.6	50.4	6.4
Refined & bleached	0.06	11.5	6.0	27.0	49.7	5.8
Refined, bleached & deodorized at 160°C	0.05	12.5	4.2	28.2	49.3	5.8

No significant differences were found in the unheated oils during the various processing steps; the over-all nutritional quality of the oil was adversely affected by the processes but the resistance of the processed oils to heat damage was improved.

Effects of Oil Pollution

By early April evidence of oil pollution was reported as far downstream as LaCrosse, Wisconsin,[2] approximately 250 river miles from the uppermost pollution source at Mankato. The greatest amount of oil, however, was concentrated back of the ice cover in Lake Pepin. Following the ice breakup in late March and early April, floating masses of soybean oil and petroleum oil moved down the Minnesota and Mississippi Rivers. By April 6 these oil masses had reached the vicinity of Frontenac on the Minnesota shore of Lake Pepin and Maiden Rock on the Wisconsin shore. Strong wind action and the lack of current in Lake Pepin resulted in much of the soybean oil being blown onto the shores. The movement of the oil mass down the Mississippi River and into accessible backwaters

coincided with the peak of the scaup migration and resulted in a substantial loss of ducks.[2]

Waterfowl may be affected several ways by oil; notable among these are:

1. Drowning - The feathers are coated and matted and buoyancy is lost.

2. Exposure - The feathers and down are penetrated, reducing their insulation capacity causing loss of body heat.

3. Starvation and prey to enemies - Mobility is reduced both in the air and on the water.

4. Intestinal Lesions - The laxative properties of ingested oils reported to produce intestinal lesions. Oil accumulation in body tissues may result in acute toxicities.

5. Suffocation - Oil becomes lodged in nostrils and throat.

Public Health Service Participation

With the start of the ice breakup on the river in late March, when the accumulated oil spills resulted in considerable losses in wildlife,* the State Executive Council of Minnesota met on April 3 and declared a state of emergency. Governor Rolvaag called the National Guard to active duty to aid other State agencies in fighting the problem.

On April 4, the Governor requested Federal assistance. The Public Health Service was assigned to investigate the problem under Section 4b of Public Law 660 (Federal Water Pollution Control Act).

Sanitary Engineering Center personnel were ordered to Minnesota on April 9 and arrived in Minneapolis-St. Paul on April 10. Conferences

* 2400 disabled ducks were counted by the State Conservation Department; actual number affected is unknown.

were immediately arranged with the State and Federal agencies participating in investigative and corrective activities associated with the problem to obtain background information and develop a plan of action. Polluted areas as well as the operations in progress for clean-up of the oil were inspected on April 11.

Public Health Service observations and plans for future activities were summarized at a meeting on April 12 with Governor Rolvaag in which F. E. DeMartini, Chief, TA&I Section, outlined the anticipated short term and long term effects of the oil pollution as follows:

1. The most serious phase of the problem was over. The bulk of the oil had moved on downstream into Lake Pepin, and, in the judgment of the PHS team, except for thin oil slicks that might continue to proceed downstream, the heavy accumulations found upstream would not be likely to move below Lake Pepin.

2. There did not appear to be an imminent significant public health hazard. Every effort, however, would be made by PHS to keep in touch with the situation by monitoring the quality of water through river samplings and analyses and by the continuous operation of three Water Quality Network stations located at Lock and Dam No. 3 near Redwing and at Dubuque and Burlington, Iowa. If necessary, Water Quality Network stations located further downstream would be used.

3. There would probably be continuing releases of soluble material and oil that would coat the stream surfaces and give visible evidence of this pollution for some time because of the material stranded along the shores and in the vegetation on the shore line.
4. The Redwing Boat Marina was the worst spot seen with respect to large accumulations of oil and, unless cleaned up, complaints from boat owners were likely to be numerous.

Furthermore, arrangements were made to have personnel from the PHS on the rivers on Monday, April 15, primarily to sample the stream and lake bottoms in various places to determine the oil concentration in the water and how much oil deposition might be present on the bottom. This work would be done in cooperation with Mr. Frank Woodward's staff. Two possible future courses of action were summarized: (1) to trace the movement of oil downstream by monitoring and to determine stream recovery or deleterious effects that called for specific action, or (2) to attempt to remove the heaviest accumulation along the stream shores, beaches, and boat harbors. If the latter course were followed the task would involve many miles of stream and the utilization of a large labor force and much equipment requiring considerable dollar resources.

It was mentioned that at eastern oil refineries diatomaceous earth had reportedly been used successfully to carry oil slicks to the bottom of the water body upon the diatomaceous earth. The use of

emulsifiers was discussed at almost every meeting, however, their use should be applied with caution, if at all. This was based upon the fact that the emulsions would probably break in due time and release the oil. Further, there might be some harmful biological side effects of the emulsifiers.

It was indicated that if the State's resources should prove inadequate, Federal aid from the President's emergency disaster fund could be requested but that certain basic requirements for such assistance must be met.

Finally, with respect to the Governor's earlier indication regarding legislative needs, it was pointed out that prevention of incidents of this type was much more effective than undoing the damage after the incident. From discussions with representatives of State agencies, legislative gaps appeared that made preventive measures very difficult, if not impossible. It was stressed that some agency of state government should be given authority to require satisfactory installation of storage tanks, oil transmission lines, etc., to prevent pollution of streams. It was also indicated that if the Governor made a specific request to the PHS for assistance and consultation about a legislative program, that consultation would be provided. The meeting proceeded with a number of questions and answers; there was the understanding that the Public Health Service would continue to follow this problem throughout the next several months, if necessary, and provide a written report to the Governor's office at a later date.

Field Sampling and Laboratory Analyses

Several samples of soya oil, cutters oil, and river water samples were taken from April 10 to 12. Arrangements were made to obtain daily samples from the Mississippi River at each Corps of Engineers Lock and Dam Nos. 2 to 15 for analysis at the SEC laboratory.

During the period April 15 to 23, a PHS field crew took samples from the two plants involved in the oil spills, and bottom samples from Lake Sturgeon, Lake Pepin and Red Wing Harbor on the Mississippi River. Arrangements were also made to secure a weekly river water sample from the raw water intake to the filtration plant at Rock Island Arsenal. Sampling at this station (April 26) was gauged to coincide with the estimated time of water travel from Lake Pepin to Rock Island based on Corps of Engineers pool capacities and flow data.

The PHS Water Quality Network[7] furnished carbon filter background analyses from stations located at St. Paul, Dubuque and Burlington. Samples were collected at these stations on a continuous basis during the period April 12 to May 12, 1963.

On June 25 and 26, bottom samples were collected from Red Wing Harbor and along the Red Wing-Bay City traverse in Lake Pepin for analysis and comparison of oil concentrations with previous results from these stations.

Crude Soya Oil Studies

Standard 5-day and long-term biochemical oxygen demand (BOD) tests indicated that the crude soya oil from the Honeymead plant has an ultimate BOD of several hundred thousand mg/l and an oxidation

rate constant higher than that of domestic sewage. These values, however, apply only to the original oil when it is uniformly dispersed in solution or emulsion. The floating and settled oil masses or clumps taken from the river or picked up on shore exhibited a relatively slow degradation.

Hydrolysis and biological decomposition of the crude soya oil results in the formation of carbonaceous decomposition products. Infrared studies of the crude oil and the hydrolysis products indicate the oil molecule is degraded by attack at the carbon-oxygen bonds and it may be assumed that the resulting organic materials are similarly degradable, but perhaps at a slower rate. There is no indication that the decomposition products would present significant problems of toxicity under aerobic conditions.

Congealed and partly polymerized oil masses collected in the vicinity of Red Wing, Minnesota, were investigated for chemical/biological degradation in river water. These studies indicated that after 3 or 4 days in water these particular samples were relatively stable. (The time of exposure of the samples to air and water in moving from Mankato to Red Wing and repose at Red Wing was approximately 11 weeks). A continuous biological breakdown of the outer surface leaches a small amount of carbonaceous material into the overlying water. The rate of degradation suggests that the oil masses will contribute a small amount of oxygen demanding substances over a long period of time. The effect of the oxygen demand from these deposits on the dissolved oxygen (DO) of

the river would depend on the amount of oil deposit present within a river stretch, but the effect would probably be minor provided the river DO is not depressed to a dangerously low level by other pollutants. Degradation of these substances under anaerobic conditions will produce hydrogen sulfide. A description of the laboratory procedure used and tabulation of the results of a leaching test made on solidified soya oil deposits are presented in Appendix "A."

The chlorine demand of soya oil mixed in water and its effect on taste and odor is variable, however, a laboratory test with 5 mg/l of crude soya oil in distilled water is presented in Table 1.

Table 1 - Chlorine Demand of Soya Oil

Chlorine Applied	Combined chlorine residual after 2 hrs.	Chlorine demand	Odor
mg/l	mg/l	mg/l	
0.9	0.4	0.5	Weak chlorinous
2.6	1.7	0.9	Weak chlorinous
5.3	4.0	1.3	None
8.8	7.0	1.8	Strong chlorine

This very limited test indicates taste and odor in water due to a soya oil concentration of 5 mg/l may be controlled by chlorine applications of 3 to 5 mg/l in addition to that chlorine usually required in oil free water.

Studies of Mississippi River Waters

Samples of river water were obtained from Lock and Dam Nos. 1 through 15 in cooperation with the Corps of Engineers, St. Paul district.

Samples were collected also from the quad-city area in cooperation with the Rock Island Arsenal and the Chicago Region Office.

Results of extraction of ether soluble materials are presented in Table 2.

Water samples from the Rock Island Arsenal averaged 1.5 milligrams of petroleum ether extractable oil per liter with a maximum of 1.8 mg/l. For all river samples the median value was 1.3 mg/l and the maximum was 4.0 mg/l. Infrared spectra indicated the extracted oil to be primarily soybean oil. Soybean oil in these concentrations should not create any appreciable problems in water treatment plants.

Water Quality Criteria, 1952 Edition, page 183, Animal and Vegetable Oils, notes that the Michigan Stream Control Commission considers 15 mg/l of such oil to be an upper limit.

The Public Health Service Water Quality Section, Basic Data Branch supplied information on analyses of carbon filter samples from National Water Quality Network stations located at St. Paul (No. 27), Dubuque (No. 26) and Burlington (No. 25). The data is presented in Table 3.

A sample of soybean oil was tested according to National Water Quality Network procedure for comparison with the oil extracted from the Mississippi River water at these stations both before the oil spill and during April 1963, when the time of passage indicated oil had passed or was passing Stations No. 26 and No. 27.

As indicated in Table 3, soybean oil, a glycerol ester of linoleic and oleic acids, is found in the neutral fraction (95%) predominantly

Table 2. TOTAL OIL IN MG/L - PETROLEUM ETHER EXTRACTABLE

Mississippi River Water Samples - St. Paul to Rock Island

1963	Corps of Engineers Lock and Dam Number															Rock Island
Date	1	2	3	4	5	5-A	6	7	8	9	10	11	12	13	14	15	Arsenal
April																	
13		0.4	0.5				3.4	0									
14			0.9	0				1.7	0								
15				0	0.5				1.3	1.3	1.2						
16					0	0				1.3	2.0						
17						4.0	2.4	2.0					1.4	2.0	2.0		
18	2.6			1.1	2.1	1.3	0.9	1.8	1.5					1.1			
19										0.7	0.8	1.0	0.8		0.9	1.4	
20									3.0	1.0	1.0	1.7	0	1.0		1.7	
21									1.6	0.7	2.1	2.3	1.7	1.5			
22									0.6		2.3	0.5	0.2	1.3	1.4		
23									0.6		1.0	2.0		0.9	0	2.0	
24				1.6					0.9		2.5	0					
25										0.8	2.1	0.8	1.0	1.0	0	1.4	
26												0.2	0.8	0.3	3.6	0.5	0.8
27												1.7	0.9	3.7	1.0	0.2	
28												1.8	0.7	1.2	2.5	0.8	
29												2.1	2.1	3.2	2.3	1.4	
30												0.4	0.9	0.7	1.5	0.9	
May																	
1												0.4	2.5	0.4	0.7		
7																	1.8
17																	1.2
31																	1.6
June																	
7																	1.8
14																	1.7

Median of all samples	1.3
Maximum	4.0
Minimum	0

Table 3. DATA FROM CARBON FILTER ANALYSES
National Water Quality Network Stations -
Mississippi River

	Soybean Oil %	Oleic Acid %	Linoleic Acid %	Station No. 25, Burlington, Iowa Mean of 10 Previous Samples ppb	%	Sample April 12 to April 26, 1963 ppb	%
Carbon Chloroform Extractables	-	-	-	57	-	66	-
Ether Insolubles	0	0	0	2	3	2	2
Water Solubles	0.3	0	0	15	26	17	25
Neutrals	95.0	1.6	3.9	18	31	23	35
aliphatics	0	12.5	0	2	9	1	6
aromatics	5.3	25.0	13.6	1	8	2	8
oxygenated compounds	87.2	62.5	86.4	14	77	17	72
loss	7.5	0	0	1	6	3	14
Weak acids	1.0	96.6	91.3	7	12	7	11
Strong acids	0	0	0.8	5	8	3	5
Bases	0	0	0	1	2	2	3
Loss	3.7	1.8	4.0	9	18	12	19

Table 3. Continued

	Station No. 26, Dubuque, Iowa				Station No. 27, St. Paul, Minnesota			
	Mean of 10 previous samples		Sample April 12 to April 19, 1963		Mean of 10 previous samples		Sample April 14 to April 21, 1963	
	ppb	%	ppb	%	ppb	%	ppb	%
Carbon Chloroform Extractables	81	-	51	-	97	-	85	-
Ether Insolubles	2	3	1	1	3	3	2	2
Water Solubles	22	27	12	23	26	27	22	26
Neutrals	22	27	20	40	31	32	32	37
aliphatics	2	9	1	4	3	10	3	9
aromatics	2	9	2	8	4	13	4	13
oxygenated compounds	17	77	15	77	23	74	22	69
loss	1	5	2	11	1	3	3	9
Weak acids	10	12	5	9	11	11	8	9
Strong acids	7	9	2	4	8	8	4	5
Bases	2	2	2	3	2	2	2	2
Loss	16	20	9	20	16	17	15	19

in the oxygenated sub-fraction (87.2%). Linoleic acid and oleic acids, the presumptive hydrolysis products of soybean oil, are found, however, for the most part in the weak acid fraction (96.6 and 91.3%). Any significant quantity of the oil or the acids in the river samples would be expected to distort the percentage of neutrals or weak acid. In mid-April the percentage of neutrals at Dubuque was 40%, at St. Paul 37%, and at Burlington 35%--compared with the 10-sample mean values of 27%, 32%, and 31% respectively. No significant increase is apparent. Similarly, the percentage of weak acids at Dubuque was 9%, at St. Paul 9%, and at Burlington 11%--compared with the 10-sample mean value of 12%, 11%, and 12% respectively. Again, no significant increase is apparent.

Infrared curves obtained with the soybean oil, linoleic acid, and oleic acid provided excellent reference spectra for comparison with the samples from St. Paul, Dubuque, and Burlington. None of the absorptive peaks singularly characteristic of these substances were found in the carbon chloroform extractables or separates from these samples. On the other hand, the spectra of the samples were extremely similar to previous spectra from these stations.

It is postulated that the material (1) may have floated (specific gravity < 1), or (2) may have polymerized and sank. In either case it would not necessarily have been taken into the carbon filter intake and sampling system. There is also reason to believe that soya oil is readily biodegradable in which case the components (3) may have been oxidized to insignificant molecular fragments.

Bottom Sediment Studies

Bottom samples were collected from Lake Pepin along a transect from Bay City, Wisconsin to Sawdust Bar. Other bottom samples were collected east of Green Point; from the Red Wing, Minnesota, Municipal Marina and from Sturgeon Lake. Some oil was observed in all samples collected. Results are presented in Table 4.

The Red Wing Marina had considerable quantities of oil in the bottom sediments. At the time of sampling, April 19, influences on the benthic fauna appeared to be minimal. A normal population of benthic organisms was observed in samples collected from Lake Pepin near Bay City, Wisconsin.

Samples collected at these same locations on June 25 indicated a severe loss of benthic organisms when compared with the April 19 samples.

Direct effects of the Minnesota-Mississippi oil spill on fishes were probably minimal. Dead fish were observed around Lake Pepin in April, but the numbers were low and within the range of mortalities that are expected in early spring.

Secondary effects of the oils may be more significant. Quantitative data on these are lacking. During oil sampling in April, numbers of the burrowing mayfly (Hexagenia spp.) a sensitive organism, were observed in the bottom muds. These organisms were not observed in these areas during the June sampling. It is possible that the oil's BOD may have deoxygenated the water at the mud-water interface, and these mayflies were asphyxiated or forced to migrate to more suitable

Table 4. BOTTOM SEDIMENT SAMPLES - MISSISSIPPI RIVER

Extractable Oil Mg/g - Soxhlet, Petroleum Ether Method

Sampling Point	Distance from shore ft.	Depth ft.	Oil Mg/g April 19	Oil Mg/g June 25
Red Wing Harbor	30	6	3.6	2.6
Red Wing Harbor	60	6	3.0	2.5
Red Wing Harbor	150	6	2.9	2.5
Red Wing Harbor	250	6	1.3	1.7
Red Wing Harbor	350	6	14.8*	2.2
Red Wing Harbor	400	6	2.6	3.2
		Average	2.7	2.1
*Concentrated sample for reference - not included in average				
Bay City	150	3	0.5	0.6
Bay City	300	5	0.4	0.6
Bay City	1200	8	1.0	1.0
Bay City	1500	8	1.5	1.2
Bay City	4000	15	1.2	1.4
Bay City Lily Pool			0.8	1.0
		Average	0.9	1.0
Sturgeon Lake	50	6	1.8	
Sturgeon Lake	100	7	1.6	
Sturgeon Lake	300	8	1.7	
		Average	1.7	
Wacuta Beach	200	8	1.2	2.6
Wacuta Beach	300	15	1.7	1.9
		Average	1.5	2.2

areas. Deoxygenation of the mud-water interface would also have a detrimental effect on fish reproduction for demersal fish eggs, resting on the bottom, would be destroyed.

LEGAL ASPECTS

At the time of these oil spills, though several State agencies were involved to some extent in water and pollution problems, none had clear-cut responsibility and legal authority to enforce measures to insure proper storage of non-waste materials or to require salvage action and cleanup if an accidental loss occurred. Action was possible only if a public health emergency was created.

The concern of responsible State authorities and the public led to revision of the State Water Pollution Control Act by the Legislature. This revised Act, known as the Rosenmeier Bill, SF No. 243, Chapter No. 874, applies to both ground water and surface water pollution. It provides for the prevention, control and abatement of water pollution by the construction and operation of waste treatment plants; prohibits the storage of any liquid not properly retained against entry into State waters; and prohibits depositing of wastes where they are likely to get into any waters of the State; and otherwise.

Another legislative Act which should significantly affect future reduction of the pollution load on the upper Mississippi River is H.F. No. 1825, Chapter No. 882, requiring the Board of Trustees of the Minneapolis-St. Paul Sanitary District to adopt a comprehensive plan for construction and financing of facilities required by the entire area served or to be served by such District.

REFERENCES

1. Corps of Engineers, U.S. Army Engineer District, St. Paul, Permits and Statistics Branch, Operations Division. "Summary of Pollution on Minnesota and Mississippi Rivers." April 1963.

2. Sharp, R. W., Nord, R. C., Larsen, Howard, Elkins, W. A., "Oil Pollution Investigation - Upper Mississippi River." Unpublished report. U.S. Fish and Wildlife Service. April 1963.

3. Svirbely, J. L., Toxicologist, Public Health Service Sanitary Engineering Center, Research Branch. Personal correspondence. May 1963.

4. The Merck Index, 7th Edition, Merck & Co., Rahway, New Jersey. 1960.

5. Wilding, M. D., Rice, E. E., and Mettil, K. F., "The Effect of Processing Conditions upon the Nutritional Quality of Vegetable Oils," Journal American Oil Chemist's Society, 40, 55. 1963.

6. Hagen, Colonel Leon H., Unpublished report on National Guard Participation in Minnesota and Mississippi River Water Pollution Disaster. April 1963.

7. Breidenbach, A. W., Analysis of Carbon Filter Samples from National Water Quality Network Stations Nos. 25, 26, 27. Personal correspondence. May 1963.

APPENDICES

A. Soybean Oil Leaching Studies 26

B. Chronology (of Events and Activities). . 30

C. Persons Contacted or Associated with the Problem 37

APPENDIX A

Soybean Oil Leaching Studies

Purpose: To determine the rate of decomposition of solidified soya oil deposits in river water at ambient temperature.

Apparatus: A 5 gallon Pyrex glass carboy containing 16 liters of Little Miami River water. Power stirring equipment. Carboy open to atmosphere and held at constant 25°C.

Procedure: Fifty grams of solidified oil from Lake Pepin was placed in bottom of carboy of water. The water was stirred constantly just sufficient to move water. Daily (work day) samples of the supernatant were removed to determine chemical oxygen demand (COD); a quantity of river water equal to the quantity removed for analysis was added to the carboy each day.

Rationale: Since oil is quantitatively oxidized in the COD test, the test is a reliable measure of the amount of oil in the overlay. Increase in COD is used to calculate increase in oil in solution.

Results: Leaching of Solidified Soya Oil

Date	COD mg/l	Net COD COD -15* mg/l	Equiv. Oil Net COD/16** mg	Increase in oil mg	Notes
4-30-63	15	15	0	← River water	
5-1-63	196	181	11	4	
5-2-63	259	244	15	2	
5-3-63	289	274	17	3	
5-6-63	340	325	20	1	
5-7-63	355	340	21	1	
5-8-63	365	350	22	-1	
5-9-63	349	334	21	2	
5-10-63	384	369	23	0	
5-13-63	400	385	23	2	
5-14-63	410	395	25	0	
5-15-63	418	403	25	0	
5-16-63	418	403	25	0	
5-17-63	421	406	25	1	
5-20-63	436	421	26	1	
5-21-63	448	433	27	1	
5-22-63	461	446	28	1	
5-23-63	477	462	29	1	
5-24-63	488	473	30	5	
5-27-63	568	553	35	1	
5-28-63	597	582	36	1	
5-29-63	604	589	37	1	

Date	COD mg/l	Net COD COD -15* mg/l	Equiv. Oil Net COD/16** mg	Increase in oil mg	Notes
6-3-63	620	605	38		
				1	
6-4-63	633	618	39		
				0	
6-5-63	635	620	39		
				0	
6-7-63	660	645	39		
				2	
6-10-63	677	662	41		
				13	
6-13-63	880	865	54		
				0	***H_2S ODOR
6-14-63	883	868	54		
				1	
6-17-63	898	883	55		
				-1	
6-18-63	886	871	54		NO H_2S ODOR
				1	
6-19-63	894	879	55		

* Initial raw water COD = 15 mg/l

** 1 mg oil equivalent to 16 mg/l COD

*** Oil film formed across top of water affecting the re-aeration rate

Discussion: The solidified oil, after an initial distribution in the river water, leached a small amount of oxygen-demanding material daily to the supernatant. This amount is approximately equivalent to one milligram per day for the 7-week period of observation.

After 28 days a significant increase in chemical oxygen demand occurred, followed by a 14-day period of slower increase. A sharp increase over the weekend was again observed, followed by a 7-day period of gradual change. During the second period of abrupt change, a strong odor of hydrogen sulfide was noted (June 13,14). One interpretation of the changes is suggested: the gradual release of material from the oil mass occurs as the result of aerobic biological action. On two occasions, probably because of an oil film on the surface, the system changed to anaerobic, which resulted in the production of hydrogen sulfide, and a consequent increase in COD.

Another consideration affecting the decomposition rate of the soya oil used in this study is the time of exposure of the oil to water and air prior to this test (January 23 to April 30).

APPENDIX B

Chronology of Events and Activities[a]

During the winter of 1962-63 two oil spills occurred on the Minnesota River, one at Savage, Minnesota, 12 miles above the junction of the Minnesota and Mississippi Rivers, and the other at Mankato, Minnesota, 76 miles above the junction.

Oil on the Minnesota River was first reported by a trapper in December 1962 to the State Department of Conservation, and a preliminary investigation was made by that agency on December 31. Oil was evident on the river downstream near Minneapolis-St. Paul, at the Northern States Power Company's Black Dog plant.

On January 14, 1963, the Conservation Department informed the Water Pollution Control Section of the State Health Department of the spill by telephone, and on January 22 a representative of the Water Pollution Control Commission inspected the Richards Oil Company site. On January 31, 1963 the Chief, Water Pollution Control Commission, wrote the Richards Oil Company to request that the company investigate the cause of the oil spill and set up safeguards to avoid recurrence of similar incidents in the future.

The State Health Department district office at Mankato reported the escape of 2 to 3 million gallons of soybean oil from a ruptured tank at Honeymead Products Company at Mankato on January 23, and an

[a] Major events are given. No attempt has been made to list all the activities of all agencies, groups and persons concerned.

engineer of State Water Pollution Control Commission inspected the site on January 24. Recommendations for disposal of oil from cleanup operations were made to the Honeymead Products Company and the city of Mankato, followed by written recommendations on January 25.

On March 25 oil was reported on the Mississippi River from St. Paul to Newport, Minnesota.

On March 27 and 28, Corps of Engineers[1] and Water Pollution Control Commission[8] personnel inspected both the Richards Oil Company and the Honeymead Products Company plants. These inspections were followed by letters from the Corps of Engineers to each company, in which Section 407, Title 33 of the U. S. Code, pertaining to discharge of refuse into navigable waters or onto the shores thereof was cited.

On March 27 the Corps of Engineers contacted the Public Health Service Region VI Office in Kansas City and described the pollution of the Minnesota and Mississippi Rivers. The next several days were active ones for the agencies involved, with events occurring as follows:

March 27. Petroleum oil followed by soybean oil, passed Hastings Dam No. 3.

March 28. State Water Pollution Control Commission personnel inspected Richards Oil property. Oil was still escaping into the Minnesota River. At Mankato, oil from broken barrels was going into the Blue Earth River. Oil from the waste dump area 2 miles east of Rapidan was flowing through a ruptured dyke into the Le Sueur River, a tributary to the Blue Earth River.

March 29. The Honeymead Products Company repaired the dyke at the dump site on the Le Sueur River.

Richards Oil Company constructed a dam and baffle to retain oil.

Heavy oil concentrations on the Mississippi River below St. Paul and wild duck kills were reported by the Conservation Department. Private citizens volunteered their services and equipment to rescue ducks incapacitated by oil pollution. Lake Pepin was covered with ice, which blocked passage of oil downstream.

March 30. Duck salvage operations continued.

March 31. Heaviest oil concentrations were reported on Spring Lake near Hastings, Minnesota. The ice in Lake Pepin began to break up. Richards Oil Company burned oil from their land.

April 1. U. S. Coast Guard ice breaker broke up ice in Lake Pepin channel. Representatives of the Corps of Engineers, U. S. Fish and Wildlife Service Minnesota Department of Conservation, and the Water Pollution Control Commission met with the Governor and Attorney General to formulate plans for rescue of ducks and wildlife. Oil was present on Lake Pepin.

April 2. Oil reached Lock and Dam No. 4, at Alma, Wisconsin, where Lake Pepin is formed.

April 3. Minnesota State Executive Council declared a state of emergency and allocated $14,000 from the Calamity Fund. Governor Rolvaag called "D" Company 682nd Engineer Battalion, National Guard, to active duty.

April 4. Governor Rolvaag requested Federal assistance. The Corps of Engineers began to lower all pool levels, except Pool No. 2, by 0.5 foot to minimize the flow and oil movement from the main channel into backwater areas, where wildlife abounded. National Guard on duty rescued ducks and constructed deflector booms in channels leading to backwater areas. Lake Pepin reported as practically free of oil.

April 5. The Rosenmeier Bill, an act providing for the prevention, control, and abatement of water pollution passed the Minnesota Senate by a vote of 59 to 5. "A" Company 682nd Engineer Battalion National Guard, was called to duty. Most of the ice was out of Lake Pepin.

April 6. Coast Guard Cutter "Fern" helped National Guard move men and equipment. National Guard[6] determined that because no appreciable success in removing oil from the surface of the Mississippi River could be achieved they should concentrate their efforts to keep oil out of duck nesting areas in Sturgeon Lake, North Lake, Spring Lake, and Weaver Bottoms by closing the runs from the Mississippi River into those areas. Oil was reported at Frontenac State Park.

April 8. Oil was still coming down the Mississippi River. Very little oil was observed on the Minnesota River.

April 9. PHS personnel at SEC were ordered to Minnesota to evaluate the problem.

April 10. PHS personnel from Regions V and VI and SEC conferred with personnel from Minnesota Departments of Health, Conservation, Fish and Game, and National Guard and met separately with Governor Rolvaag, Mr. William L. Shovel, and Colonel Leon Hagen.

April 11. PHS personnel inspected polluted areas from air, ground, and water. The Department of Conservation supplied a quantity of Franks X-22 emulsifier to Lock and Dam Nos. 2 through 10. The results of emulsifier applications have not been reported, however, use of emulsifier on partially polymerized soya oil probably is of limited and questionable value.

April 12. PHS personnel conferred with the Corps of Engineers, U. S. Fish and Wildlife Service, and Minnesota Conservation Department. A second morning conference was held with representatives of the State Health Department and Water Pollution Control Commission. During the afternoon, in a conference with the Governor, Mr. Frank E. DeMartini outlined the PHS activities to date and presented to the Governor several suggestions for his consideration. In attendance were representatives of the National Guard, Conservation Department, and the Attorney General of Minnesota. Mr. Ralph Hovind from the Wisconsin Department of Resources Development represented the Governor of Wisconsin. Arrangements were made with the Corps of Engineers, Operations Division, to obtain daily water samples at each Lock and Dam, Nos. 2 through 15, for the next successive 20 days. These samples were shipped to the SEC laboratory for analyses. Arrangements were made with the PHS Water Quality Network to supply data

on carbon filter samples from stations at St. Paul, Dubuque, and Burlington and to obtain water samples continuously at these stations during the next 4 weeks.

April 13. A slug of oil passed through the Wabasha area of Lake Pepin.

April 15. PHS field crew began sampling of the Minnesota and Mississippi Rivers and the two plant sites where the oil spills occurred.

April 16. National Guard personnel were dismissed with the exception of a small cleanup crew.

April 18-20. National Guard and a crew of local laborers worked to clean Red Wing Harbor.

April 23. PHS field crew completed the sampling run and transported the field samples to the SEC laboratory in Cincinnati. Arrangements were made with the operator of the water treatment plant at the Rock Island Arsenal to ship a Mississippi River water sample to the SEC laboratory each week until analytical results indicated no further need for this monitoring of oil.

May 2. Some oil was still going into the Minnesota River at Port Richards. Oil was observed on river at Mankato, but no oil was observed going into the Le Sueur River from the dyked disposal area.

May 13-14. Oil continued to escape into the Minnesota River from the Richards Oil property.

May 22. The Water Pollution Control Act (Rosenmeier Bill) was passed by the House of Representatives and signed by the Governor on May 27.

June 24-27. Public Health Service field crew from Cincinnati collected bottom samples from Lake Pepin at Red Wing, Bay City, and Wacouta. Contacts were made with the Governor's office, State Conservation Department, State Water Pollution Control Commission, U. S. Fish and Wildlife and Corps of Engineers.

June 25. The Corps of Engineers began dredging of Red Wing harbor to eliminate any problems, at this location, due to oil accumulations on the bottom.

APPENDIX C

Persons Contacted or Associated with the Problem

STATE OF MINNESOTA

Governor's Office

Governor Karl Rolvaag
William L. Shovel, Administrative Assistant

Executive Council

Governor Karl Rolvaag
Walter F. Mondale, Attorney General
Stafford King, Auditor
Val Bjornson, Treasurer
Joseph Donovan, Secretary of State

State Legislature

Sen. Gordon Rosenmeier - Little Falls
Sen. Robert Dunlap - Plainview
Sen. Clarence Langley - South St. Paul
Sen. Paul A. Thuet - South St. Paul
Rep. Roy Voxland - St. Paul
Rep. C. H. Miller - Kellogg
Rep. Edward Rasmussen - South St. Paul
Rep. Howard Albertson - Stillwater
Rep. Robert Ashbach - St. Paul

Water Pollution Control Commission

R. N. Barr, M.D., Secretary
Chester Wilson, Legal Advisor
Lyle H. Smith, Engineering Executive Officer
George R. Koonce, Chemical Engineer

Department of Health

F. L. Woodward, Director, Division of Environmental Sanitation
Russell Frazier, Director, Engineering Laboratories
Jerry Allen, Assistant Sanitary Engineer
Lovelle E. Ritche, Geologist

Department of Conservation

Clarence Prout, Commissioner
Richard L. Knox, Deputy Commissioner
Frank Murray, Legal Advisory
John Moyle, Supervisor, Section of Research and Planning
Forrest Lee, Supervisor, Game Research Unit
B. R. Jones, Supervisor, Biological Services Unit
Robert Jessen, Biologist, Research
Dave Vesall, Supervisor, Section of Game
D. H. Ledin, Asst. Supervisor, Section of Game
Michael Casey, Regional Game Manager
Richard Wettersten, Wildlife Project Leader
Maynard Nelson, Research Biologist
Paul Bremmer, Game Biologist
Earnie Boyd, Warden
Kenneth La Boone, Warden
Don Gray, Supervisor
Norman Anderson, Warden
Willis Kruger, Warden
Dale Peterson, Warden
Ronald Shager, Warden

National Guard

Brig. Gen. Chester J. Moeglin, State Adjutant General
Col. Leon Hagen, Asst. State Adjutant General
Lt. Col. Donald Crowe
Capt. John D. Abrahamson
Capt. Richard Leiviska - Company "A" 682nd Engrs. Battalion
Lt. Donald Jason - Company "D" 682nd Engrs. Battalion
Maj. Roland Alms
Lt. J. C. Litschke, Pilot

Others

Dwaine Warner, Curator of Birds, Museum of Natural History
F. Robert Edman, Secretary, Minnesota Municipal Commission
Harry Rardin, Head, Red Wing Harbor Commission
John A. Fletcher, Director, Como Park Zoo
John Friedrich, Alderman, Red Wing
Lewis Patterson, Staff Writer, St. Paul Dispatch
Jackie Germann, Staff Writer, St. Paul Pioneer Press
Jack Connor, Staff Writer, Minneapolis Star
Fred Jonson, Red Wing Daily Republic Eagle
Charles L. Horn, Chairman, Minnesota Emergency Conservation Committee
Ray Young, Wabasha Herald
L. E. Cook, Editor, Gc hue Tribune
Frank Muirhead, Hastings Gazette
H. G. Seyforth, Ellsworth
James I. Moslon, Vice President, Honeymead Products Co.
Dean Meurer, Chemist, Honeymead Products Co.

STATE OF WISCONSIN

Governor's Office

Governor John Reynolds
Ralph Hovind, Division Resources Development
C. A. Wirtz, Head District Office, Conservation Department

Others

L. E. Klinger, Editor, Pepin Herald
Dale Dosdall, Mayor, Bay City
S. C. Sorenson, Bay City
Lester Johnson, U. S. Representative 9th District
Lloyd Spriggle, Bay City

FEDERAL AGENCIES

Corps of Engineers

L. A. Hauser, Jr., Chief, Operations, St. Paul District
Franklin J. Ryder, Chief, Permits and Statistics, St. Paul District
Starkey Grove, Jr., Chief, Projects Operations, St. Paul District
Henry Herich, Chief, Reservoir Regulation, St. Paul District
Robert Cleventine, Chief, Operations Division (Rock Island District)

Fish and Wildlife Service

Robert W. Burwell, Regional Director
W. A. Elkins, Acting Regional Director
R. W. Sharp, Regional Supervisor
F. E. Davis, Regional Supervisor, Management and Enforcement
C. J. Griffin, Coordinator, Conservation, Education
R. C. Nord, Fish Biologist
Howard Larsen, Pathologist, Hatchery Branch
Arthur Hawkins, Flyway Biologist
William Ellerbrock, Game Management Agent
Urban C. Nelson, Chief, Division Wildlife

Coast Guard

Lt. John Sutton, Senior Inspector, Dubuque, Iowa

Public Health Service

Region VI - Donald A. Townley, Chief, Enforcement Section
Donald W. Marshall, Chief, Water Quality Section

Region V - John M. Rademacher, Chief, Enforcement Section
James O. McDonald, Construction Grants

Robert A. Taft Sanitary Engineering Center

Technical Advisory and Investigations Section

Frank E. DeMartini, Chief
W. M. Ingram, Chief, Biological, Chemical and Oceanographic Activities
F. W. Kittrell, Chief, Pollution Evaluation
H. H. Black, Industrial Waste Consultant
G. Walton, Chief, Water Supply and Waste Treatment
J. L. Morris, Sanitary Engineer Director
D. G. Ballinger, Supervisory Chemist
C. R. Hirth, Chemist
K. M. Mackenthun, Biologist
L. E. Keup, Biologist